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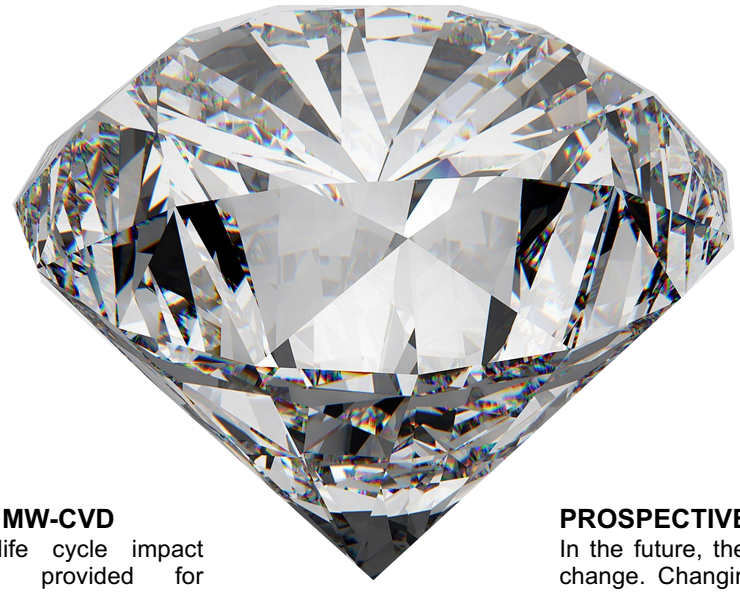
Life Cycle Environmental Impacts of Synthetic Diamond Production

OUR RESEARCH

Synthetic diamond is a superhard material found in applications including e.g. cutting and grinding of rocks and metals but also in windows and analytical equipment lenses. Synthetic diamond clearly dominates the industrial diamond use (with about 99% over its natural counterpart) and is mainly produced via high-pressure high-temperature (HPHT) synthesis. Microwave chemical vapor deposition (MW-CVD), is also used but to a lesser extent. Most synthetic diamond is produced in China. Until now, no study has conducted a life cycle assessment (LCA) of conventional synthetic diamond production. The aim of this study is to conduct a cradle-to-gate LCA of conventional synthetic diamond production via HPHT and MW-CVD.



COMPARING HPHT AND MW-CVD

Preliminary results from life cycle impact assessment (LCIA) are provided for conventional production of 1 gram diamond single crystals, < 1mm, via HPHT and 1 gram diamond layer, via MW-CVD with different scenarios for the background electricity system. Input of cemented carbide apparatus parts constitute the main hotspot in the HPHT synthesis while the electricity required for the apparatus dominate in the MW-CVD synthesis.

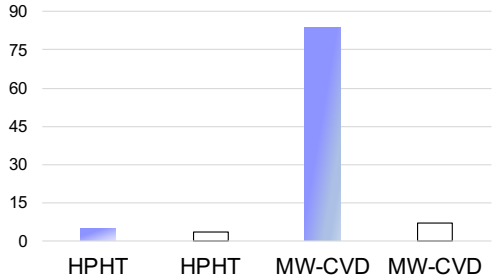
PROSPECTIVE ASPECTS

In the future, the electricity mixes might change. Changing e.g. from a Chinese electricity production mix to solar-based electricity significantly decreases the impacts. Effects of up-scaling in the foreground system will be investigated in the future.

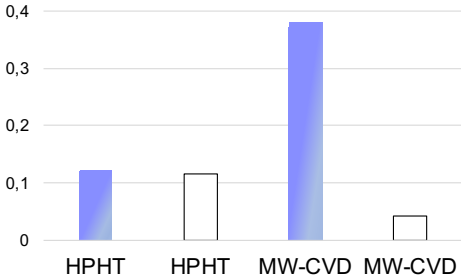
Background electricity system:

- Production mix, China, Guangdong
- Solar electricity

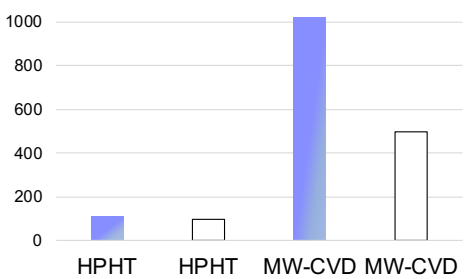
Climate change [kg CO_2 eq/g]



Terrestrial acidification [kg SO_2 eq/g]



Cumulative energy demand [MJ eq/g]



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